A PENNY-SHAPED FRACTURE PROBLEM IN THE PRESENCE OF THE STEIGMANN-OGDEN SURFACE ELASTICITY

Anna Zemlyanova

ABSTRACT

Fracture problems with Steigmann-Ogden surface energy on the boundary are presented in the talk. The Steigmann-Ogden surface elasticity model treats a material surface as a zero-thickness membrane which possesses its own Lame parameters, surface tension, and bending rigidity. Mathematically, this allows to treat elasticity problems at nanoscale within the continuum approach. In particular, a problem for a nanosized penny-shaped fracture in an infinite homogeneous isotropic elastic medium is considered. The fracture is opened by applying an axisymmetric normal traction to its surface. The surface energy in the Steigmann-Ogden form is acting on the boundary of the fracture. The problem is solved by using the Boussinesq potentials represented by the Hankel transforms of certain unknown functions. With the help of these functions, the problem can be reduced to a system of two singular integro-differential equations. The numerical solution to this system can be obtained by expanding the unknown functions into the Fourier-Bessel series. Then the approximations of the unknown functions can be obtained by solving a system of linear algebraic equations. Accuracy of the numerical procedure is studied. Various numerical examples for different values of the surface energy parameters are considered. Parametric studies of the dependence of the solutions on the mechanical and the geometric parameters of the system are undertaken. It is shown that the surface parameters have a significant influence on the behavior of the material system. In particular, presence of surface energy leads to the size-dependency of the solutions and smoother behavior of the solutions near the tip of the crack.

REFERENCES

[1] Zemlyanova, A.Y., 2021. An axisymmetric problem for a penny-shaped crack under the influence of the SteigmannOgden surface energy. Proceedings of the Royal Society A, 477(2248), p.20200998.